Diatom Assemblages In The Sediments Of The Big Eau Pleine Reservoir Marathon County, Wisconsin

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Diatom Assemblages And Sedimentary Chlorophyll Degradation Products In The Sediments Of The Big Eau Pleine Reservoir, Wisconsin.

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Abstract

Stratigraphic analysis of a sediment core obtained from a deep depression in the Eau Pleine Reservoir, Wisconsin was made in 1976. The depth distribution of fossil diatoms and sedimentary chlorophyll degradation products were used to assess the trophic development of the reservoir since its formation in 1937. A sudden change in these historical markers was evident from the shift in the Eau Pleine River to Reservoir environment. The Centrales diatom tribe developed rapidly in the reservoir sediments and was parallelled by a marked decline in the Araphidineae group. Trophic indicies indicate an increase in eutrophication since reservoir formation. This is also supported by a steady increase in sedimentary chlorophyll degradation products in reservoir sediments. High levels of sedimentary chlorophyll pigments immediately after reservoir construction are characteristic of a "trophic upsurge" in reservoir productivity. The mean depostion of the organic fraction derived after reservoir formation was 0.8 cm per year.

INTRODUCTION

Lake sediments can provide historical information regarding the development of present day environments since glacial times. A survey of the vertical distribution of pollen in sediments can lead to formulations of previous terrestrial plant communities that have developed since the retreat of the glaciers or since the lake's formation. Terrestrial plant communities can signal changes in previous climatic conditions, cultural activities by man, or other environmental factors. Other biological indicators, as well as, chemical and physical properties of sediments, may provide an additional tool for discerning previous environmental conditions that lead to the development of recent environments.

My goal was to explore how diatoms could be utilized for assessing the development of the Big Eau Pleine Reservoir, Wisconsin (T26N, R5, and 6 E) since its formation in 1937. It was hypothesized that the sediments in the reservoir would exhibit a marked difference in physical, chemical, and biological components due to the shift from the Big Eau Pleine River to reservoir environment. My emphasis in this study was placed on the enumeration and identification of fossil diatoms; however, additional data on chlorophyll degradation products and organic content were obtained to supplement the diatom survey. This project was undertaken for the fulfillment of an independent study course (Natural Resources 796) under the direction of

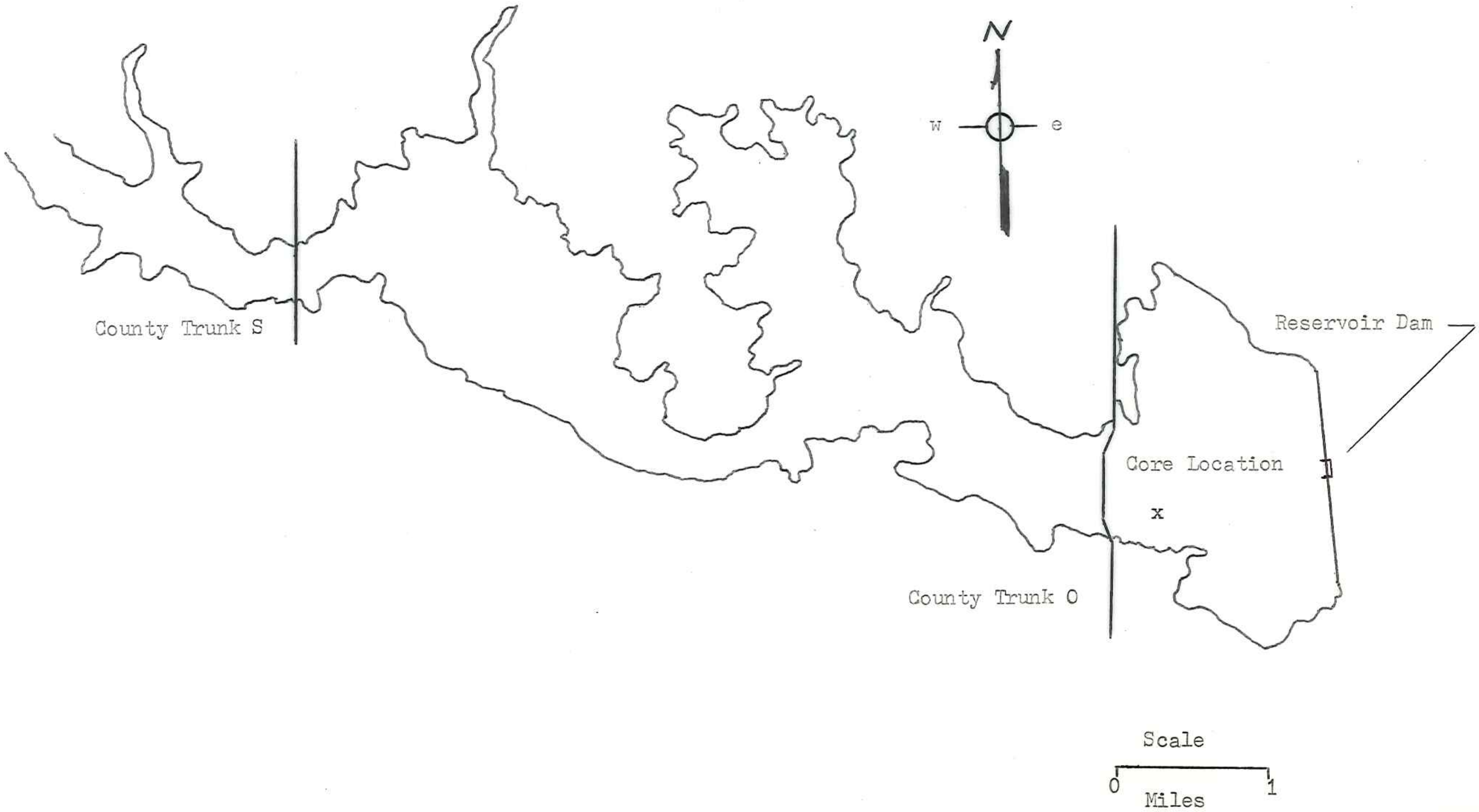
Dr. Ted Roeder, University of Wisconsin-Stevens Point in the fall of 1976.

Methods and Procedure

A short core approximately 45 cm. long was obtained in a deep depression just east of County Trunk O in January of 1976 (Map 1). The depth at this location would be about 38 ft. at the highest stage elevation of the reservoir. This site was chosen because surface sediments were organic in nature and were not exposed during periods of maximun drawdown. The core was taken through the ice using a check valve apparatus at the end of a series of 5/8 in. conduit piping. A 3 cm. inside diameter by 1m. long plastic tube (PVC) was attached to the check valve apparatus to complete the core assembly. the coring device could be pushed into the organic sediments with ease and retrieved without loss in sediment material. The effects of composition were minimal and were not accounted for in this study.

The core was transported back to the lab in a vertical position where it was immediately frozen inside the plastic tube. One week later the core was removed from the tube and sliced up into 1 cm. intervals throughout the entire length of the core. Each slice was homogenized in a small aluminim dish using a glass rod. Then, subsamples (approx. 3-5 grams wet wt.) were prepared and weighed to the nearest miligram for the determination of sedimentary chlorophyll pigments, organic content, water content. and diatoms. The sediment

Eau Pleine Reservoir
Marathon County, Wisconsin



chlorophyll degradation products (SCDP) were extracted and analyzed by a procedure developed by Vallentyne (1955). The organic content was estimated by the loss on ignition procedure by igniting samples for 8 hours at 550°C. Diatoms were cleaned in a nitric acid and potassium dichromate solution and were prepared for counting by a method used by Stockner and Benson (1967). The cleaned samples were repeatedly decanted and diluted with distilled water until no traces of acid were detected. Cleaned samples were diluted to 100 ml. from which 10 drops (approx. .5 ml.) were removed and placed on a 22x22 mm. cover-slip. The keys of Patrick and Reimer (1966), Weber (1971), and Hustedt (1930), were used to identify the taxa found.

Results and Discussion

Core Description and Comments

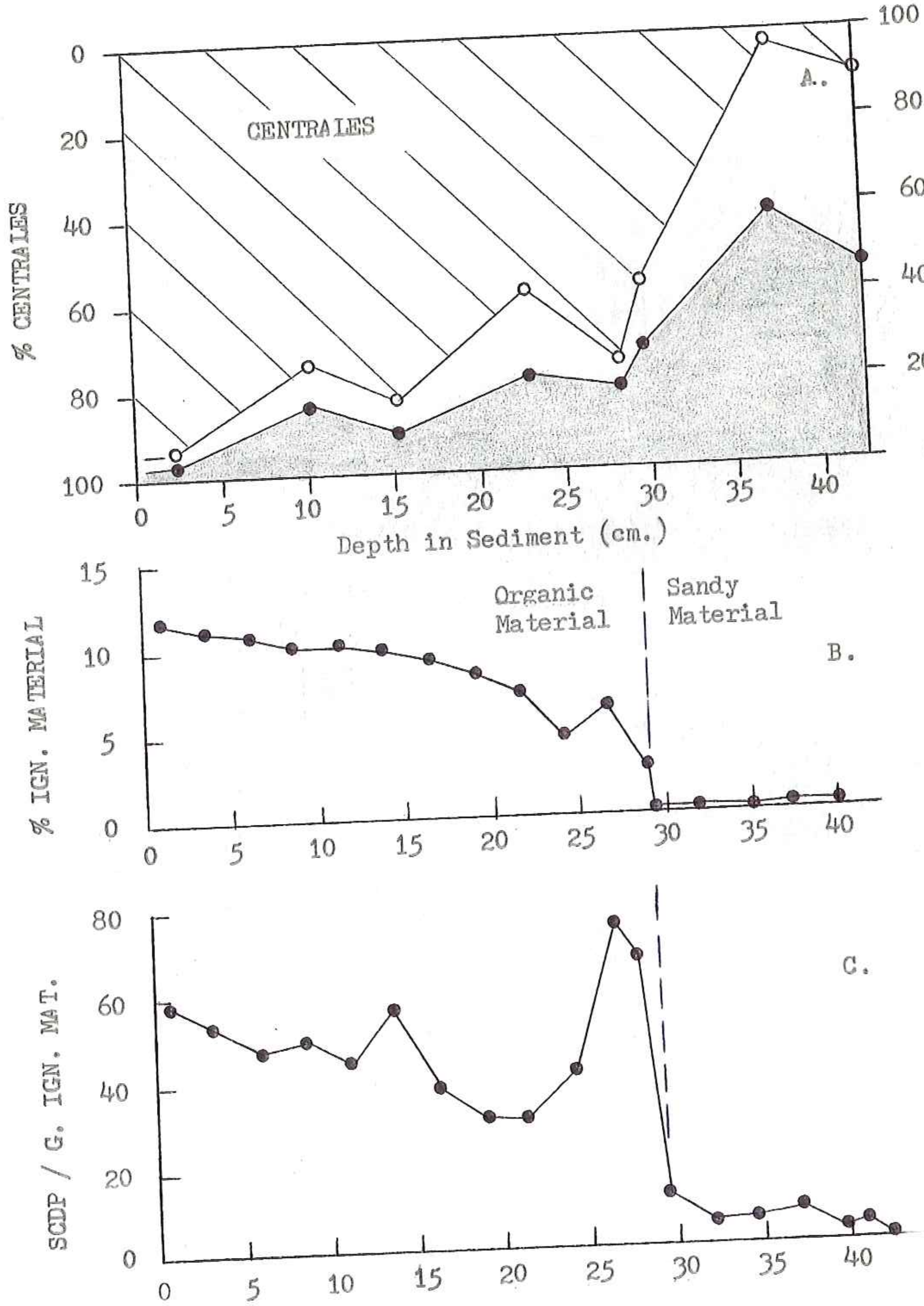
The core obtained from Eau Pleine Reservoir exhibited a distinct 16 cm. sandy layer which was covered with 29 cm. of organic material. A deeper core could not be collected because of the difficulty of the core penetration in the lower sandy sediments. From these initial observations, it was assumed that the sandy to organic layer interface marked the boundary between the river and reservoir sediments respectively. The mean depositional rate of the organic deposits since the formation of the reservoir in 1937 is approximately .8 cm. per year at the core location. This depositional rate predicted is probably largely inflated in terms of the reservoir as a whole. Gorham and Sanger (1972) have noted that slumping of organic material in deep basins may yield very high depositional rates. Slumping and redistribution of organic sediments, as well as associated biological indicators to deep water areas, may play an important role in the accumulation of detritus in the Eau Pleine Reservoir due to the nature of water level manipulations. I have only analyzed data from a single core which precludes a measurement of the actual trends in organic matter deposition, and chemical and biological indicator accumulations. I believe, however, that the relative changes of biological and chemical components can be established from data collected on a single core.

Organic Matter and Sedimentary Chlorophyll

Data collected on loss on ignition analysis is a rough approximation of the total organic content of the sediment (Pennington, 1943). The organic content of the reservoir sediment increased steadily since the time of initial organic matter deposition at the 29 cm. level (Fig. 1B). A noted rise in the organic content was present at 26.9 cm. followed by a gradual accumulation to the present level of roughly 11% of the total dry weight.

Sediment chlorophyll degradation products (SCDP) are expressed in terms of the weight of ignitable or organic material in Fig. 1C. When sedimentary chlorophyll units are expressed in terms of the organic matter content, the data are independent of the rate of mineral sedimentation (Vallentyne, 1955). * It is believed that increases of SCDP per gram organic matter are a relative index to lake eutrophication (Vallentyne, 1955; Fogg and Belcher, 1961; and Moss 1967). The results obtained for the Eau Pleine Reservoir indicate a sharp accumulation of

Figure 1



CENTRALES
A.
% CENTRALES
% ARAPHIDINEAE
Depth in Sediment (cm.)
Organic Material
Sandy Material
B.
% IGN. MATERIAL
C.
SCDP / G. IGN. MAT.

of chlorophyll degradation products at 28 cm. followed by a decline to the 20 cm. level where pigment concentrations increased gradually to the surface sediments (Fig. 1C). Thus, the results obtained would suggest a gradual increase in reservoir fertility. In addition, one can speculate that periods of elevated pigment concentration are associated with increased levels of primary production; however, this must be done with caution with data on a single core unless other indicators are considered as well. I will come back to this topic when I discuss the results of my diatom survey.

The extreme jump in sediment chlorophyll degradation products at 29.0 cm. would support the original hypothesis that this layer is the beginning of the reservoir sediments. The reason for this sharp boundary of pigment content between the sandy and organic deposits are two fold. First, chlorophyll pigments are preserved in sediments that are anoxic, free of light, and cold (Vallentyne, 1955). Lakes and reservoirs which have periods of hypolimnetic anaerobic conditions are excellent environments for the formation of sediments with preserved plant pigments. The Big Eau Pleine Reservoir sediments are anaerobic in nature, whereas the previous river sediments were probably oxidized at most times of the year. In addition, the Eau Pleine River sediments would be exposed to elevated temperatures and light because of shallow water levels which would be unfavorable for plant pigment preservation. The second reason for greater concentrations of chlorophyll pigments in the organic sediments may arise from the type and amount of pigment containing organic material. In large lakes, the increase in pigment content of sediments is usually associated with autochthonous input derives from algal growth and decay (Vallentyne and Craston, 1957; from Fogg and Belcher, 1961). This factor probably accounts for the pigment content of the reservoir sediments as well. Further, it was found through the use of Gorham's index (ratio of absorption at 410nm/350nm) that pre-reservoir sediment pigments were of terrestrial origin. High ratios indicate autochthonous input, whereas lower values would be indicative of a terrestrial source of organic material (Gorham 1959, 1960). A terrestrial source of organic material coupled with a poor environment for pigment preservation is probably responsible for the low sedimentary chlorophyll units obtained from the sandy sediments of the Eau Pleine River (below 29 cm.).

Diatoms

A complete listing of the diatoms identified and counted at 8 levels of the 45 cm. core is presented in Table 1. Twenty-two genera were encountered which accounted for 68 species. Of the 68 species, 8 remain unidentified at the present time. Sample numbers 1-8 correspond to 2.3, 10.1, 15.2, 23.0, 28.2, 29.5, 37.3, and 52.5 centimeters from the top of the core respectively. Samples were collected from approximately 5-8 cm. intervals throughout the length of the core. An exception is at the boundary between the sandy and organic sediments (29 cm.) where samples were collected just prior to (29.5 cm.) and after (28.2 cm.) initial organic matter deposition (Fig. 1A and 1B). It was believed that these 8 samples

Table 1

Diatoms identified from the Big Eau Pleine Reservoir

Species	Sample number							
	1	2	3	4	5	6	7	8
Centrales								
Cyclotella glomerata	11	-	-	-	6	2	-	-
C. *meneghiniana*	7	8	6	6	13	8	5	9
C. *stelligera*	-	10	-	3	3	2	-	-
C. unknown - 58	-	1	-	-	-	12	-	-
C. spp.	-	-	-	-	2	-	-	-
Melosira distans	-	2	1	-	-	-	-	-
M. *granulata*	4	3	14	36	49	49	-	-
M. *islandica*	2	-	4	-	9	-	-	-
M. *italica*	26	105	30	35	6	-	-	8
M. *varians*	2	1	-	1	-	-	-	-
M. spp.	122	75	161	120	184	97	6	15
Stephanodiscus astraea	-	1	1	-	-	1	-	-
S. *niagarae*	132	32	32	14	-	4	-	2
S. spp.	1	-	-	-	-	-	-	-
Pennales								
Achnanthes exigua	-	-	-	-	-	-	1	-
A. *lanceolata* and varieties	1	3	-	6	2	1	13	22
A. *stewartii*	-	-	-	-	1	-	-	-
A. spp.	-	-	-	-	1	-	2	3
Asterionella formosa	2	14	-	1	9	10	-	2
Cocconeis placentula var. lineata	-	-	-	-	-	1	-	1
Cymbella affinis	-	-	-	1	1	-	-	-
C. *tumida*	-	-	-	-	1	-	1	-
C. *ventricosa*	-	-	-	-	-	-	-	3
C. spp.	-	1	-	2	1	2	2	3
Diatoma ciculare	-	-	-	-	-	1	-	-
Epithemia zebra	-	-	-	-	-	-	-	1
E. spp.	-	-	-	1	-	-	-	2
Eunotia curvata	-	-	-	-	-	1	-	-

would be adequate to analyze the relative trends in the past diatom flora of the Eau Pleine River and Reservoir environment; however, additional samples at more intervals and including more cores would be necessary for a more refined approach. The latter technique was impossible due to the time required for such research. The information obtained from the diatom survey will be correlated with the data collected on pigment and organic content of the sediments which should support the relative changes found.

Centric and Araphidineae Diatoms

Research of fossil diatoms has indicated that the indicator species approach to past environmental conditions is limited by our knowledge of the ecology and the physiology of the species represented (Stockner and Benson, 1967; Stockner 1971; and Bradbury and Megard, 1972). These authors have found that the ratio of Araphidineae to centric (A/C) diatoms is an appropiate indicator of lake trophic status and is not limited by inadequate knowledge of the ecology and nutritional requirements of the species encountered. In recent sediments of Lake Washington (Stockner and Benson, 1967), Lake Shagawa (Bradbury and Megard, 1972), and Lake Windermere (Stockner, 1971) a marked increase in the percent composition of Araphidineae and a decline in the centric diatom flora were noted. In all cases these changes correlated with sewage discharge or human disturbance in the watershed.

A plot of the composition of centric and Araphidineae diatoms is illustrated in Fig. 1A. It is immediately apparent that a dramatic shift in the ratio of A/C occured between the lower sandy sediments to the present organic sediments. Present sediments are overwhelmingly dominated by centric diatoms, whereas past sediments were characterized by Araphidineae diatoms, as well as members of the Monoraphidineae and Biraphidineae tribes. This shift is unusual from the previous research by others authors mentioned above. That is, under eutrophic conditions, the number of individuals of Araphidineae should increase with a corresponding drop in Centrales numbers (Stockner, 1971). However, Stockner has pointed out that his relationship may not hold on "rivers and their impoundments" because of the nature of isothermal conditions. Further, the ratio A/C may not be useful for lakes which have been in a state of eutrophy for some time. Bradbury and Megard (1972) have noted that the ratio is inadequate when eutrophic centric diatoms are abundant. Thus, the nature of the shift from Araphidineae to centric diatoms may not be associated with changes in the trophic status per se, but rather with a change in the overall environment. The abundance of Minoraphidineae and Biraphidineae individuals in the sandy sediments and their low occurence in the organic deposits support the hypothesis of an environmental related change. The latter two tribes are primarily of littoral or benthic origin (Stockner and Benson, 1967 and Bradbury and Megard 1972). Littoral and benthic diatoms are sparse in the organic fraction because light penetration is poor and submergent vegetation is restricted in the reservoir.

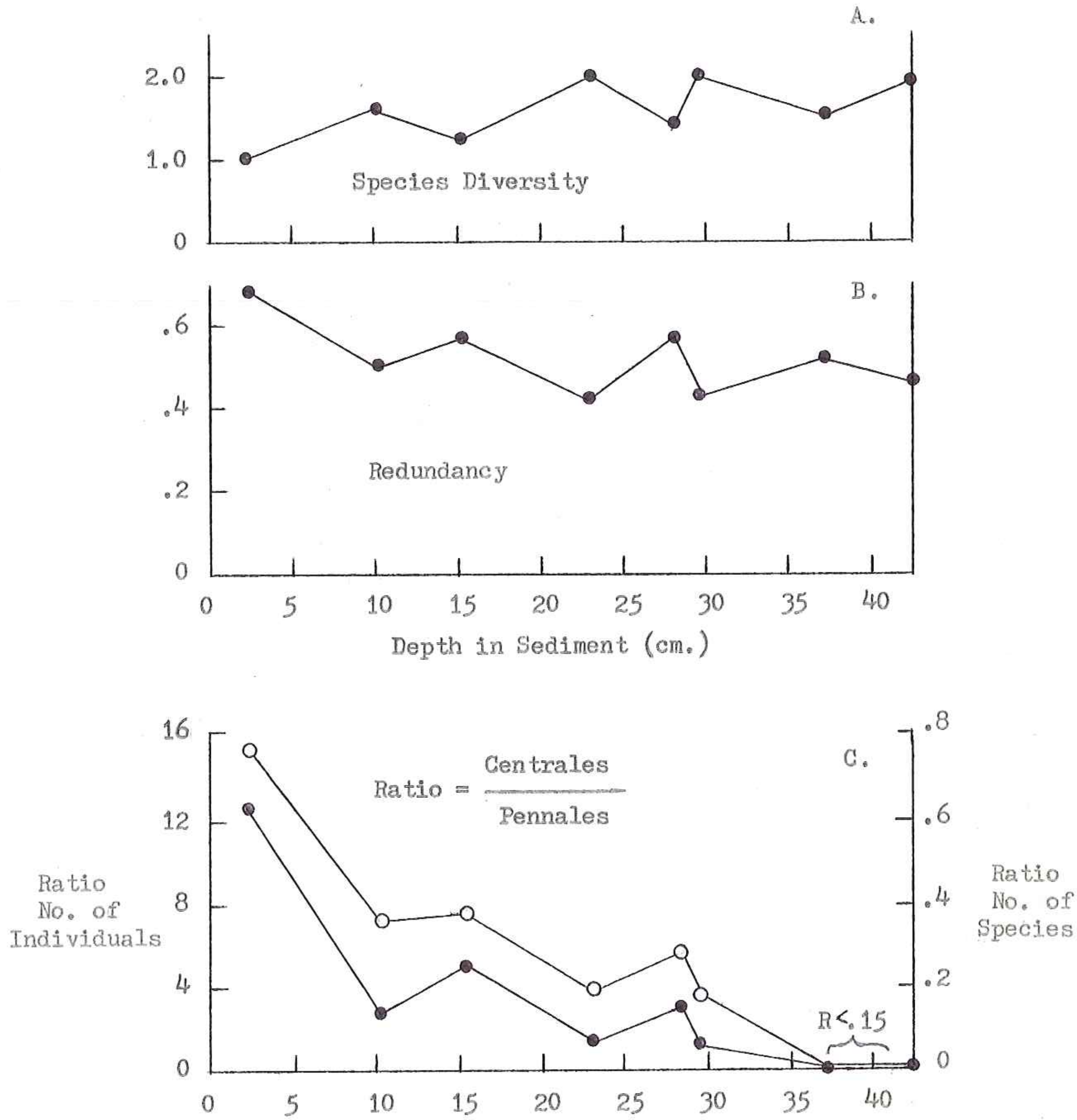
Thus, the isothermal eutrophic condition of the reservoir environment may favor centric diatoms that grow well under enriched states.

Diversity and Redundancy

In my study of the diatom flora of the reservoir, I used the approach that Stockner and Benson (1967) used for estimating species diversity and redundacy. Diversity was derived from the Shannon-Wierner Information Function and is based on the relative proportions of each species rather than actual abundance. An increase in diversity is associated with oligotrophic systems while a decrease indicates enriched or eutrophic environments. The Shannon-Wierner Information Function is useful because it reduces the effect of a large number of rare species especially when the rare species encountered are derived from areas not associated with the environment of interest (Stoermer and Yang, 1968). This approach is useful since recent sediments of the Eau Pleine Resevoir may receive large numbers of species with few individuals from the tributaries of the drainage basin and are not really associated with the reservoir environment. The extent of this phenomenon can not be determined from a single core.

Figure 2 A illustrates the species diversity encountered in the core. Although the number of levels sampled restricts a detailed interpretation, a general discussion can be made. It can be seen that the diversity is declining to its lowest levels in the recent sediments. A similar but more dramatic shift in diversity in recent sediments was found in Lake

Figure 2


A.
2.0
1.0
0
Species Diversity
B.
.6
.4
.2
0
Redundancy
0
5
10
15
20
25
30
35
40
Depth in Sediment (cm.)
16
12
8
4
0
Ratio
No. of
Individuals
C.
Ratio = Centrales / Pennales
.8
.6
.4
.2
0
Ratio
No. of
Species
R<.15
0
5
10
15
20
25
30
35
40

Washington (Stockner and Benson, 1967) and Lake Huron (Stoermer and Yang, 1968). The authors attributed this change to lower diversity in recent sediments to an increased level of eutrophication. A similar explanation is probable for the slow decline in diversity found in the Eau Pleine Reservoir. Increased levels of chlorophyll degradation products (Fig. 1B) which are probably the result of elevated levels of reservoir productivity support this hypothesis. The low values for diversity found (1.0-2.0) indicate that the diatom flora in the sediment is rather sparse in terms of the number of species present. Stoermer and Yang (1968) have indicated that diversity was quite low in a core obtained from the Lake Huron. They reported a high of 2.5 using the same diversity index.

Redundancy is a measure of repetitious counting and is inversely related to diversity. An increase in redundancy implies a skewed distribution of species and also eutrophic conditions (Stockner and Benson, 1967). Figure 2B represents the redundancy of samples collected from the reservoir sediments. A gradual increase in redundancy in recent sediments is noted. Redundancy can be directly correlated with the phytoplankton quotient that Nygard and his cohorts developed concerning the ratio of species of Centrales/Pennales diatoms presented in Fig. 2C (Rawson, 1956). An increase in this ratio particularly above .2 indicates increased eutrophy according to Nygard. Thus, this quotient compares favorably with data collected on pigment and organic content of the sediment as well as diatom diversity. The number of individuals of Centrales/Pennales diatoms shows a similar response to that of species. The increase in species and number of individuals of centric diatoms, and a similar decrease in the Pennate flora, were most significant in the changes in diversity and redundancy observed.

Major Genera and Species

Interpretations of diatom taxa in sediments can be used as indicator organisms for assessing past environmental conditions provided the data obtained is treated cautiously (Round 1964). Round has indicated that the absence or presence of species of diatoms in sediments can be related to various physical and chemical factors associated with their preservation. He suggests that "solution of species, erosion or abrasive conditions" may limit the identification or preservation of diatoms. He has reported that long fragile forms such as *Fragilaria crotonesis*, *Asterionella spp.*, *Synedra spp.*, and *Nitzschia spp.* are not preserved in some sediments due to these factors. In addition, Stoermer and Yang (1968) have noted that predation of diatoms in the profundal environment may play a role in diatom destruction. Finally, the absence or presence of various species in sediments will depend on their associated physiological requirements for growth. All of the above factors may be important in determining whether or not certain species are present or absent in some environments. The ability to use diatoms as indicator organisms, then, depends on the assurance of preservation in the sediments and the knowledge of their environmental requirements for growth. In my study, the enumeration of species was difficult because of the large number of broken frustules that were found. For this reason, the number of species found and their relative abundance may be somewhat inaccurate although this should not influence the relative changes in the diatom flora I was studying.

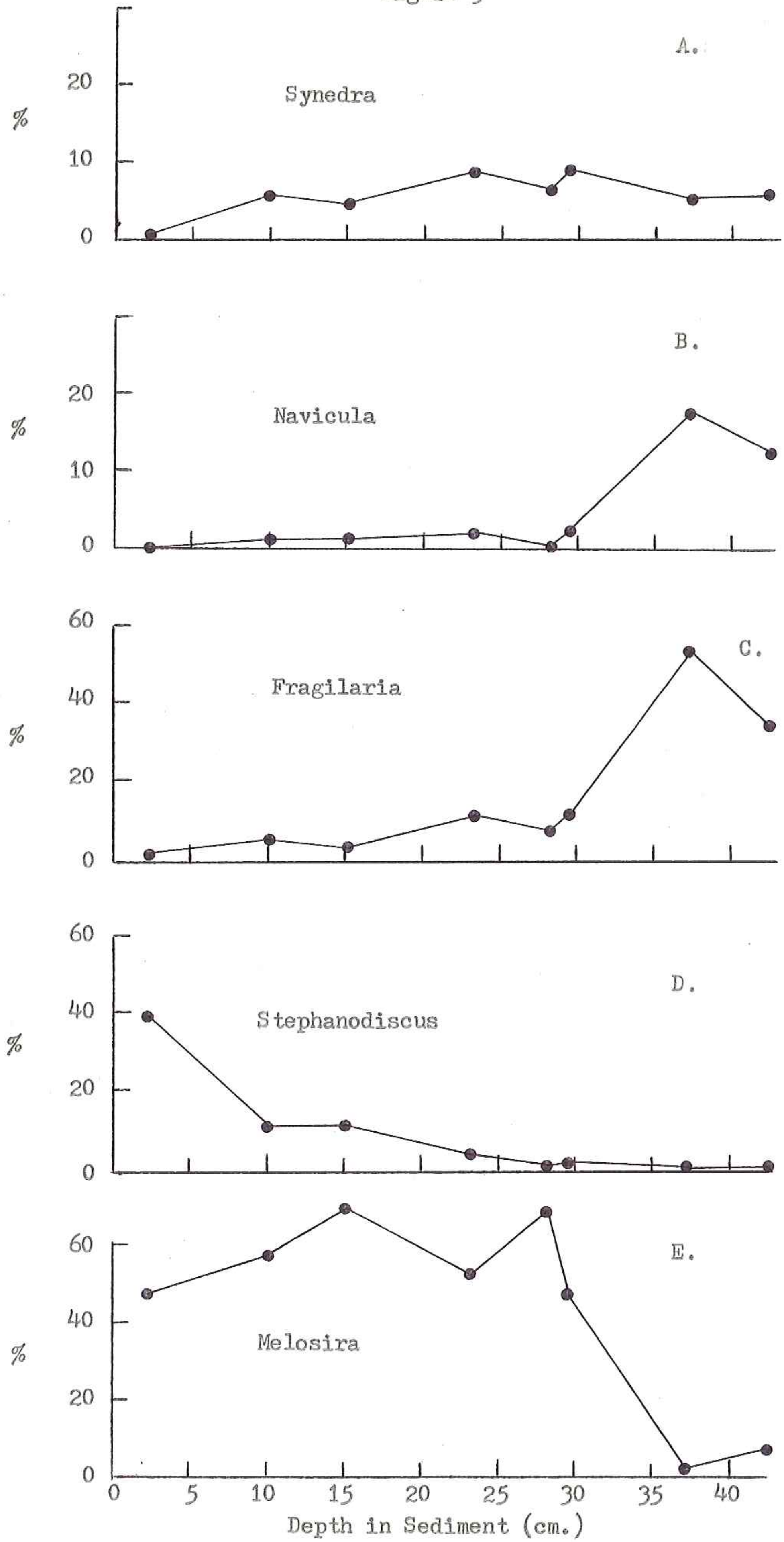
The major genera and species encountered in the Eau Pleine Reservoir core are presented in Figures 3 and 4. These taxa were plotted because of their dominance at certain levels of the core or becuase of their consistent appearance throughout the core length. I used a Mann-Whitney U Test (Cox, 1976) in order to determine whether there was a significant change in the taxa in the lower sandy sediments to the later organic deposits. The method involved the ranking of taxa in terms of their proportions for the 8 samples collected from the core. Then a comparison was made between sample

Table 2

Rank comparison between the reservoir and river sediments using a Mann Whitney U Test

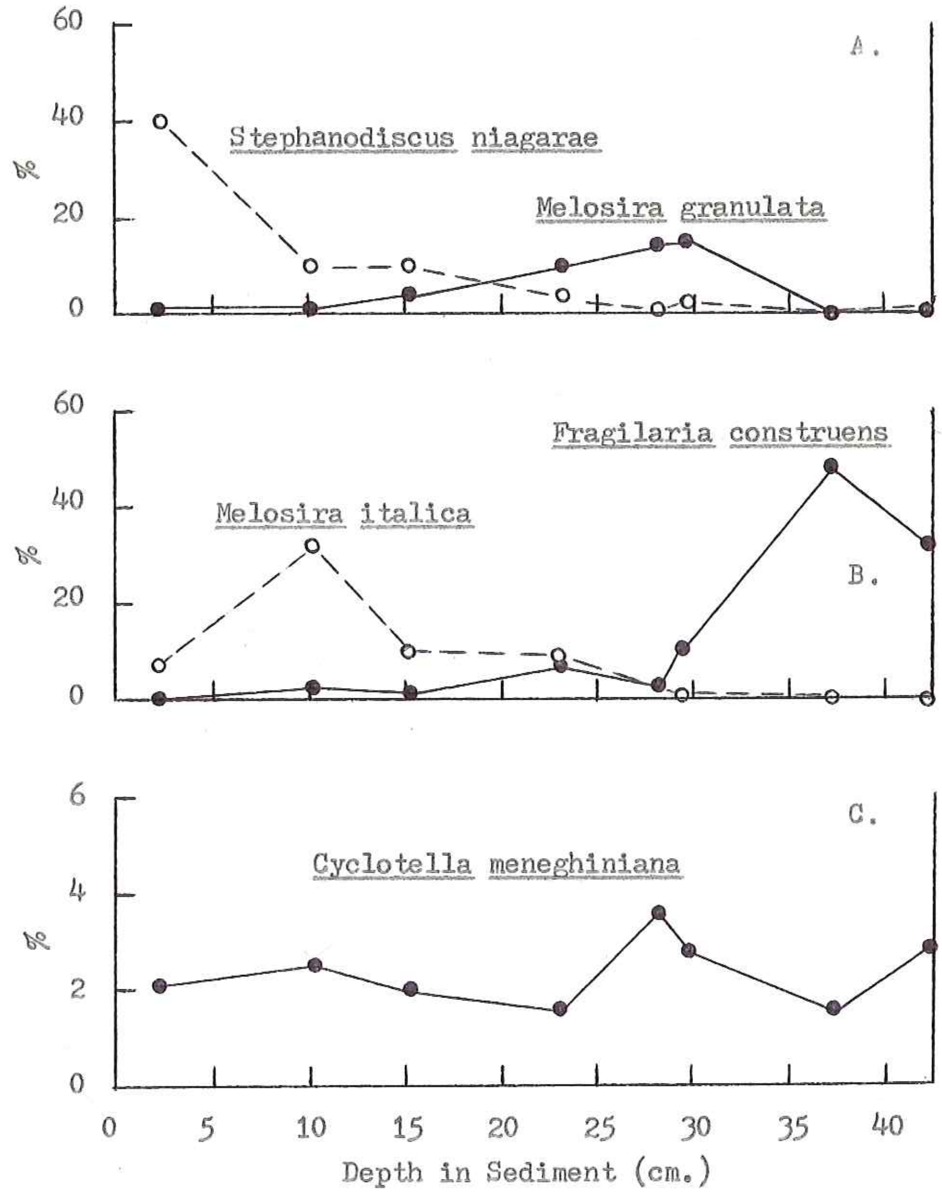
Taxa	Avg. Rank Reservoir (0-29 cm.)	Avg. Rank River Sed. (29.5-42.5cm.)	Significance Level
Melosira	6.0	2.0	95%
M. italica	5.8	2.0	95%
Fragilaria	3.0	7.0	95%
F. construens	3.0	7.0	95%
Navicula	2.8	7.0	95%
Synedra	4.2	5.0	95%

Figure 3



A.
Synedra
20
10
0
%
B.
Navicula
20
10
0
%
C.
Fragilaria
60
40
20
0
%
D.
Stephanodiscus
60
40
20
0
%
E.
Melosira
60
40
20
0
%
0
5
10
15
20
25
30
35
40
Depth in Sediment (cm.)

Figure 4


60
40
20
0
%
A.
Stephanodiscus niagarae
Melosira granulata
60
40
20
0
%
Fragilaria construens
Melosira italica
B.
6
4
2
0
%
C.
Cyclotella meneghiniana
0
5
10
15
20
25
30
35
40
Depth in Sediment (cm.)

numbers 1-5 and 6-8 which correspond to reservoir and river sediments respectively. The results of the rank comparison between the river and the reservoir sediments are presented in Table 2. The methodology for the rank comparison between two core intervals was derived from Stockner and Benson (1967). There was a significant decline (95%) in the relative abundance of the genera Synedra, Navicula, and Fragilaria (Fig. 3A, B and 3C). The change in abundance of the genus Fragilaria was largely due to the significant drop in Fragilaria construens and varieties illustrated in Fig 4B. The genus Melosira showed an explosive development in the organic sediments (Fig. 3E). The development of Melosira was supported in part by a significant increase in M. italica (Fig. 4B). Several other species of Melosira were present (Table 1), although I had some difficulty in determining their numbers because of identification problems. For that reason, most of the cell counts on this taxa were biased towards the genera level of identification. Proportioning out the counts obtained for Melosira to the various species present in a core sample did not change the diversity significantly, so my difficulty in identifying species should not influence the overall interpretation. Melosira granulata also developed early in the organic layer but decreased in relative abundance in recent sediments (Fig. 4A). The genus Stephanodiscus had an abrupt rise in recent deposits although the increase was not significant at the 95% level (Fig. 3D and Table 2). Stephanodiscus niagarae was the dominant species accounting for this trend in this genus.

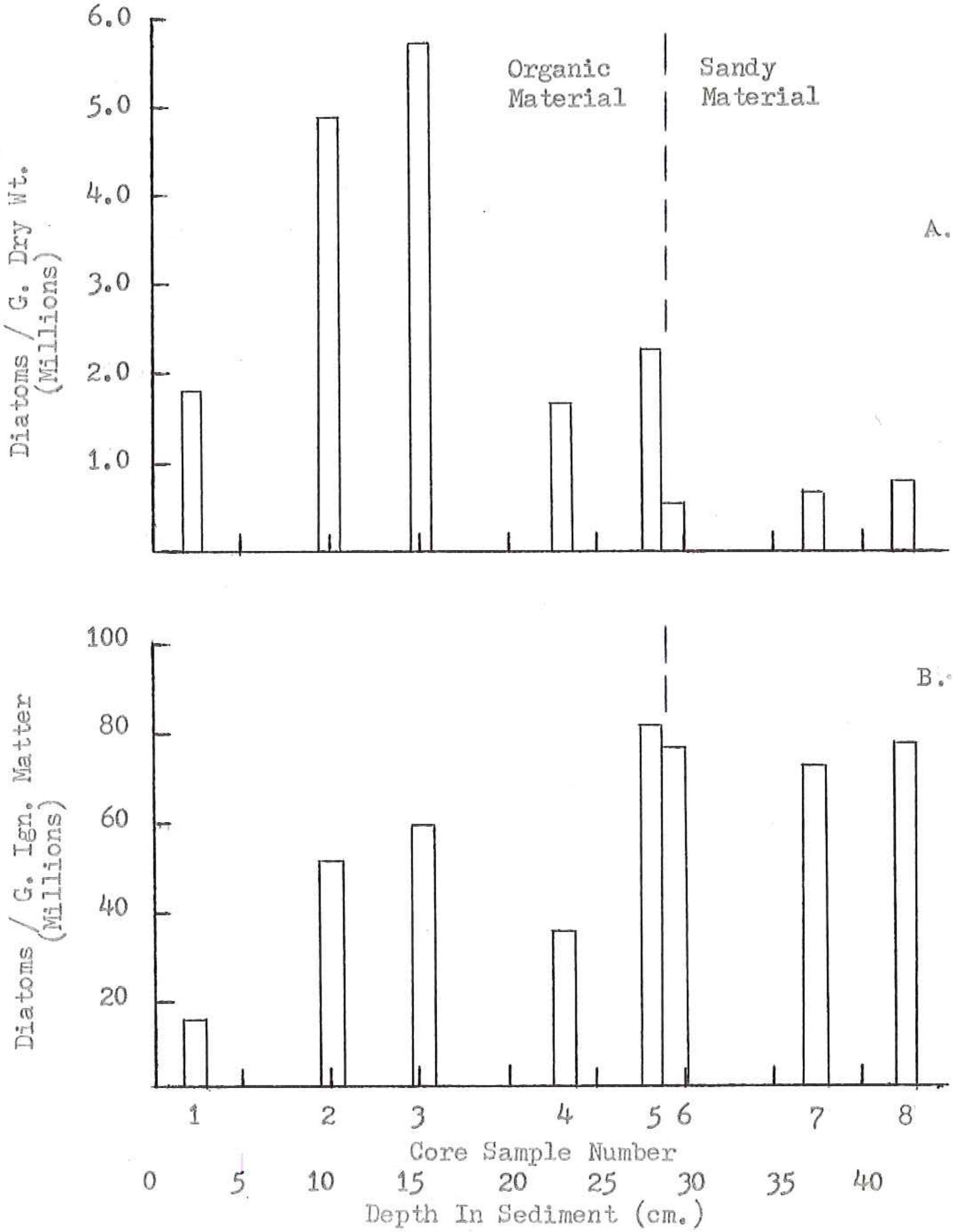
The presence of Cyclotella meneghiniana throughout the core indicates that the environment was in a eutrophic state before the reservoir formation (Fig. 4C). This species is associated with mesoeutrophic to eutrophic conditions (Williams and Scott, 1962; Stoermer and Yang, 1968; and Stockner, 1971). Other major eutrophic species found include Stephanodiscus niagarae and Melosira granulata (Huchinson et al., 1956). The genera Melosira and Stephanodiscus comprised 50 to 80% of the diatom flora collected from the organic layer and can be classified as eutrophic genera according to Foged (1954) from Rawson (1956). It appears that Stephanodiscus is replacing Melosira as the dominant genus in the most recent deposits (Fig. 3D and E), but too few samples were collected to substantiate this trend. The abundance of Melosira italica may be somewhat unusual from the standpoint of an indicator species since Stockner (1971) has classified this species as an oligotrophic indicator which is a common species found in the nutrient poor waters of the Experimental Lakes Area in Northwestern Ontario. The genera Fragilaria and Navicula comprise about 50-60% of the relative abundance of samples collected from the lower sandy layer (Fig. 3B and C). The Araphidineae member Fragilaria construens (and varieties) is the most important species in the sandy material. This species is reported to have a wide distribution and can be found in oligotrophic to mesoeutrophic environs (Patrick and Reimer

1968). Many authors have indicated that F. construens is a littoral species with some preference to shallow water (Bradbury and Megard, 1972; Hutchinson et al., 1956; and Conger, 1939). The greater concentration of the littoral and benthic Biraphidineae, Monoraphidineae and Raphidineae tribes (Stockner, 1971) illustrated in the sandy deposits (Fig. 1A, Clear Zone) supports the belief that F. construens is a shallow water indicator. It was found that species of Fragilaria were important contributors to the Araphidineae group during times of pollution in a stratigraphic analysis of the diatom flora of Shagawa Lake, Minnesota (Bradbury and Megard,1972). The occurence of this phenomenon in the sandy deposits supports the theory that the river environment was enriched prior to reservoir formation. The significance of the gradual decline in the genus Synedra is not known. This taxa was most difficult to identify because of numerous broken frustules.

Diatom Abundance

Up to this point any discussion of the concentration of diatoms present was limited to their relative or proportional occurence. In Figures 5A and B a means of quantifying the numbers of diatoms observed is presented. Diatoms are expressed in terms of dry weight in Fig. 5A and by organic matter in Fig. 5B. A discussion of diatom abundance by either of these two techniques could lead to an erroneous interpretation. That is, one would be inclined to indicate that the diatom flora increased in the organic sediments by Fig. 5A, but

Figure 5



6.0
5.0
4.0
3.0
2.0
1.0
Diatoms / G. Dry Wt. (Millions)
Organic Material
Sandy Material
A.
100
80
60
40
20
Diatoms / G. Ign. Matter (Millions)
B.
1
2
3
4
5 6
7
8
Core Sample Number
0
5
10
15
20
25
30
35
40
Depth In Sediment (cm.)

decreased according to Fig. 5B. Round (1964) has pointed out the possibility of such interpretations. He states that errors of this type are common since a decline in numbers per gram dry weight may represent a dilution with inwashed sand while a rise may be associated with increased organic matter content. This means that the nature of diatom abundance throughout the length of the Eau Pleine core can't really be determined. The discussion that follows will be restricted to the abundance of diatoms in the organic and sandy fractions alone.

Very little information can be drawn from the abundance of the diatom flora in the sandy material. The values obtained for the number of diatioms per gram dry weight (Fig.5A) are similar to the levels that Round (1960) found in a core collected from the eutrophic Esthwaite Water in the English Lake District. The reason for this correlation is obscure since our diatom counts are from two different environments - a river in this study and a lake in his. The diatom flora appears to be extremely abundant in the sandy deposits when counts are expressed in terms of organic matter by loss on ignition analysis (Fig. 5B). However, this is primarily due to a very low organic CONTENT of this material as illustrated in Fig. 1B. I have not obtained data from other work of diatom studies in river sediments so comparisons of my work with others is not at hand.

Diatom abundance in the organic deposts can be correlated to some degree with data collected on chlorophyll degradation products presented in Fig. 1C. There appears to be a very

Summary

The research has indicated that changes in the diatom flora of the Big Eau Pleine Reservoir and River sediments could be correlated with changes in the sedimentary chlorophyll pigments and previous research. The biological and chemical indicators used in this study were very useful in assessing the development of a reservoir from a previous river environment. It should be stressed that the data collected is really qualitative in nature since only one core was collected. The summary below is biased towards sediments in deep basins, and does not represent the overall accumulation of biological and chemical indicators in the reservoir.

1. The mean deposition of organic material at the sample site was 80 mm. per year.

2. Sedimentary chlorophyll pigments gradually increase in reservoir sediments and are possibly associated with increased eutrophication. High levels of pigment concentration just after reservoir formation may be suggestive of increased primary production at that time.

3. The Centrales tribe developed rapidly in the reservoir sediments and was associated with a marked decline in the Araphidineae group. This change in the diatom community

is probably the result of the sudden change in the physcial environment, and is not associated with a change in the trophic level of the environment.

4. Species diversity decreased in recent sediments which implies increased eutrophication. Redundancy increased in the reservoir sediments and can be correlated with a change in the relative abundance of Centrales and Pennales diatoms. Increased redundancy corresponded to an increase in the number of species and individuals of centric diatoms and was associated with a corresponding decrease in pennate forms.

5. There was a significant increase (95% level) in the genus Melosira, and specie M. italica in the reservoir sediments. The diatom genera Navicula, Synedra, and Fragilaria and specie F. construens were dominant taxa in the river deposits. The genus Stephanodiscus exhibited an abrupt rise in the more recent organic sediments, but this was not a significant rise from the previous river environment. The presence of Cyclotella meneghiniana and species of Fragilaria in the river deposits indicate an enriched environment was present prior to the construction of the reservoir.

6. The concentration of diatoms found in the reservoir sediments are extremely high when compared to an eutrophic lake. The main reason for this phenomenon is due to the high rate of deposition of organic material and associated biological and chemical indicators.

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